Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

PEBT 5304

Fifth Semester Examination – 2013

BIOCHEMICAL REACTION ENGINEERING

BRANCH : BIOTECH

QUESTION CODE : C- 323

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*
The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) Differentiate between space time and space velocity.

(b) Write the difference between integral and differential method of data analysis.

(c) What is enzyme immobilization ? Briefly describe the principles of two methods of immobilization.

(d) What are the advantages of fluidized bed reactors over packed bed reactors ?

(e) What do you mean by psychometric chart ? Write the use of psychometric chart.

(f) Show the relation between temperature and rate constant for high and low activation energies.

(g) What is critical dilution rate ? What happens to specific growth rate at critical dilution ?

(h) On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order.

(i) Consider an isothermal gas-phase reaction $A \rightarrow 4R$. Calculate ε_A with 50% inert present at the start of the reaction.

(j) For a reaction $E + S \leftrightarrow ES \rightarrow E + P$, the $k_1 = 1 \times 10^{-7}\ mol^{-1}sec^{-1}$, $k_{-1} = 10^2\ sec^{-1}$, $k_2 = 3 \times 10^2\ sec^{-1}$. Calculate k_m.

P.T.O.

2. (a) Derive an expression for velocity of an enzyme catalyzed reaction under 'uncompetitive inhibition'. Assume steady state conditions. 5

(b) What are the drawbacks of linearized forms of Michaelis-Menten equation ? 5

3. (a) Derive the performance equation of a PFR operating in ideal condition. 5

(b) Derive the expression for Recycle reactor. 5

4. Discuss, in detail, the integral method of data analysis for irreversible unimolecular first order reaction and irreversible bimolecular type second order reaction. 10

5. (a) A microorganism contains an enzyme that hydrolyzes glucose-6-sulfate (S). The enzyme has km of 6.7×10^{-1} μM, V_{max} of 300 nmole/L.min. Galactose-6-sulfate is a competitive inhibitor (I). At 10^{-5} M galactose-6-sulfate and 2×10^{-5} M glucose-6-sulfate, velocity was 1.5 nmole/L.min. Find K_i for galactose-6-sulfate. 5

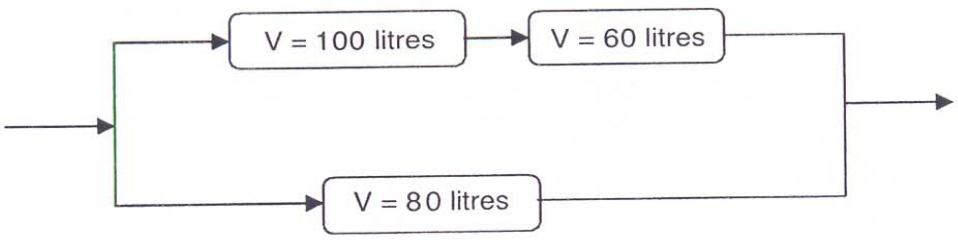
(b) For an enzyme catalyzed reaction, the initial rate V_0 was determined at each initial concentration of substrate S_0.

The following data were generated :

S_0 (μM/L)	V_o (μM/L)
1	2.5
5	9.8
10	20.2
20	31.7
30	41.2
50	50.2
100	60.1
500	74.3

Determine K_m and V_{max} from Eadie Hofstee plot. 5

6. (a) The reactor setup (shown in Figure) consists of three plug flow reactors in two parallel branches Branch D has a reactor of volume 100 litres followed by a reactor of volume 60 litres. Branch E has a reactor of volume 80 litres. What fraction of the feed should go to branch D ? 5



(b) An aqueous feed of A and B (400 litre/min, 100 m mol A/litre, 200 m mol B/litre) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by

$$A + B \rightarrow R, \quad -r_A = 200\, C_A C_B \text{ mol/litre .min}$$

Find the volume of reactor needed for 99.9% conversion of A to product. 5

7. (a) Derive the equation for analysis of data by integral method for a 2nd order reaction operating in varying volume batch reactor. 5

(b) The conversion of cyclopropane to propene in the gas phase is a first-order reaction with a rate constant of $6.7 \times 10^{-4}\ s^{-1}$ at 500°C. 5

(i) If the initial concentration of cyclopropane was 0.25 *M*, what is the concentration after 8.8 min ?

(ii) How long (in minutes) will it take for the concentration of cyclopropane to decrease from 0.25 *M* to 0.15 *M* ?

8. Answer any ***two*** of the following : 5×2

(a) Write a short note on autocatalytic reaction.

(b) Write short note on Monod's model of growth kinetics

(c) Derive a performance equation for reactor containing porous catalyst particle.

(d) Write a note on size comparison between batch, mixed flow and plug flow reactors for a given duty.